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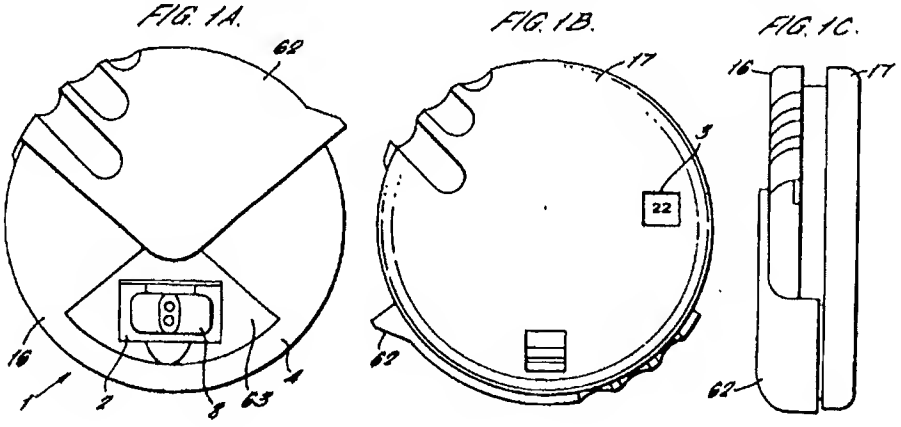
(54) Abstract Title
Drug dispensing system

(57) Apparatus for administering powdered drugs by inhalation comprises a housing 4, a mouthpiece 2 defining an outlet 8, a multi-dose cartridge (10) within the housing comprising a number of dosage units (11) each having one or more chambers sealed by a frangible membrane (22), a probe (30) and means to move the cartridge relative to the probe between actuations of the dispenser to prime the apparatus. The probe is movable to pierce the frangible membrane and enter one of the dosage units and comprises an air inlet (40) connected to atmosphere and an air outlet (41) connected to the mouthpiece such that when a user inhales at the mouthpiece, an airflow is created through the dosage unit to entrain the product therein.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1A.

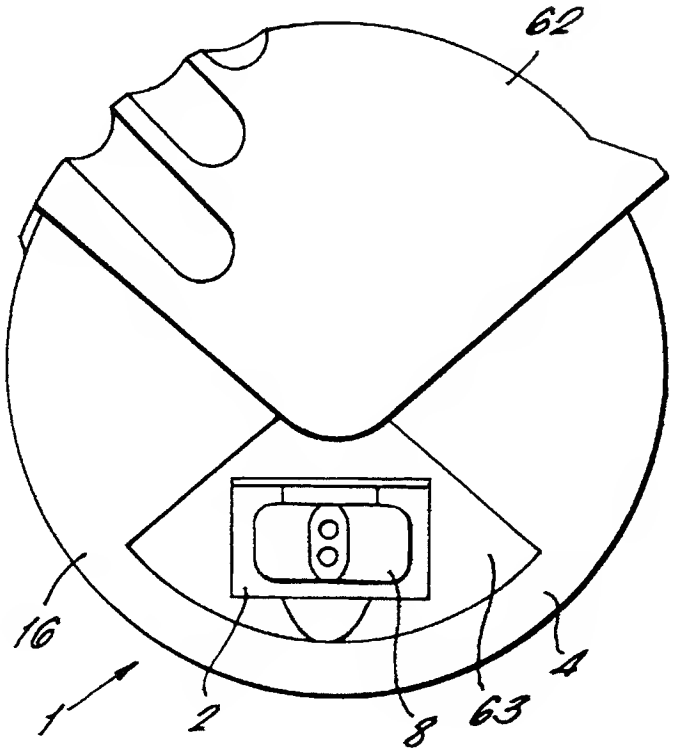


FIG. 1B.

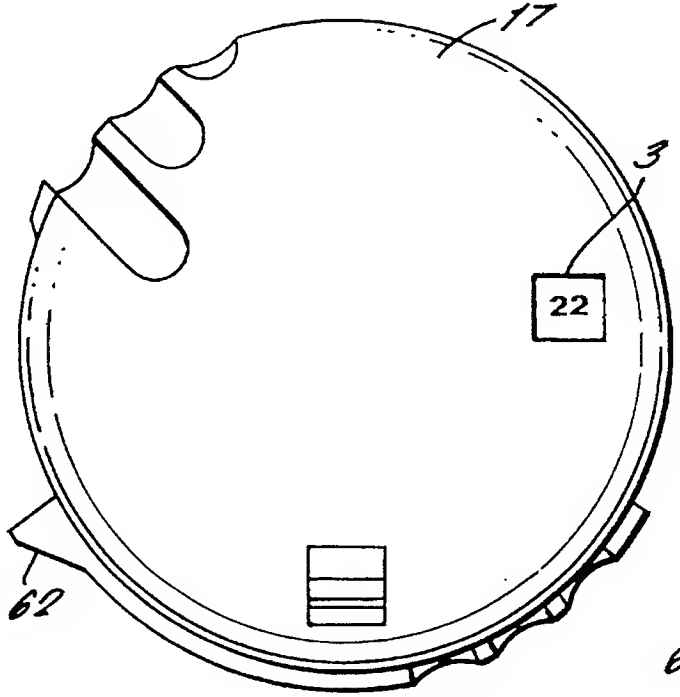


FIG. 1C.

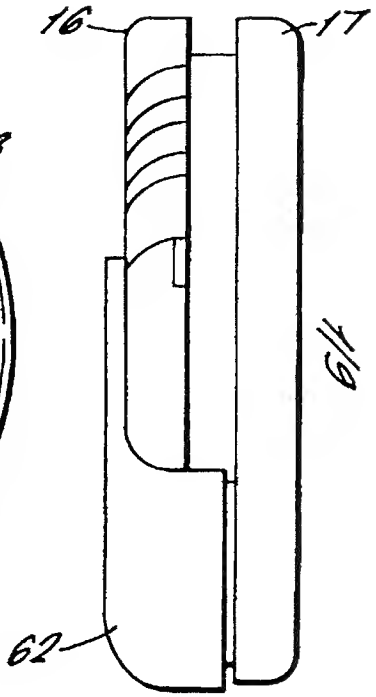


FIG. 2A.

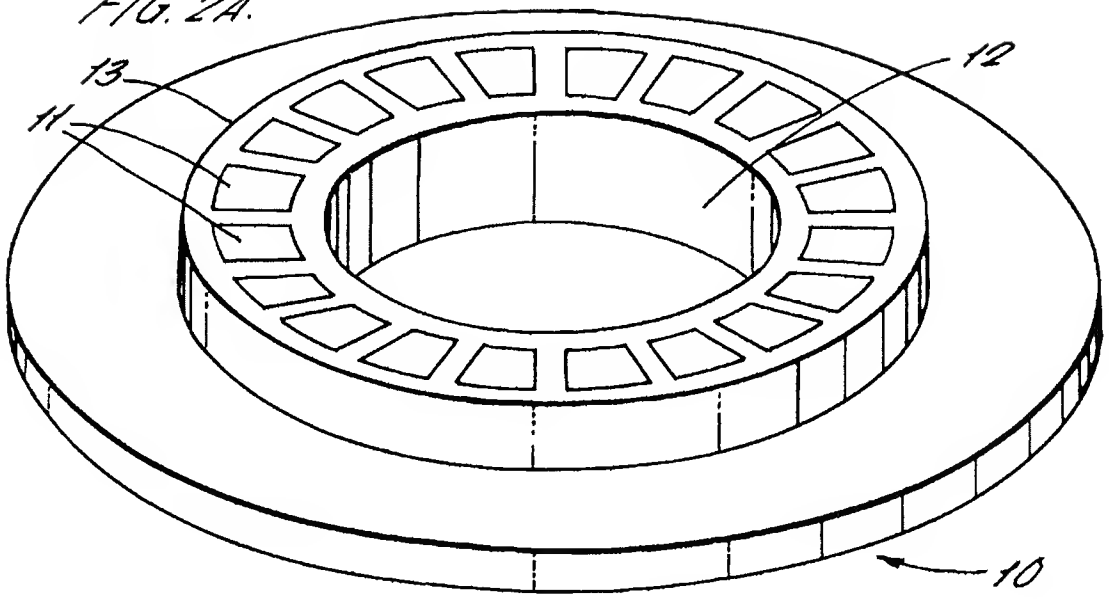


FIG. 2B.

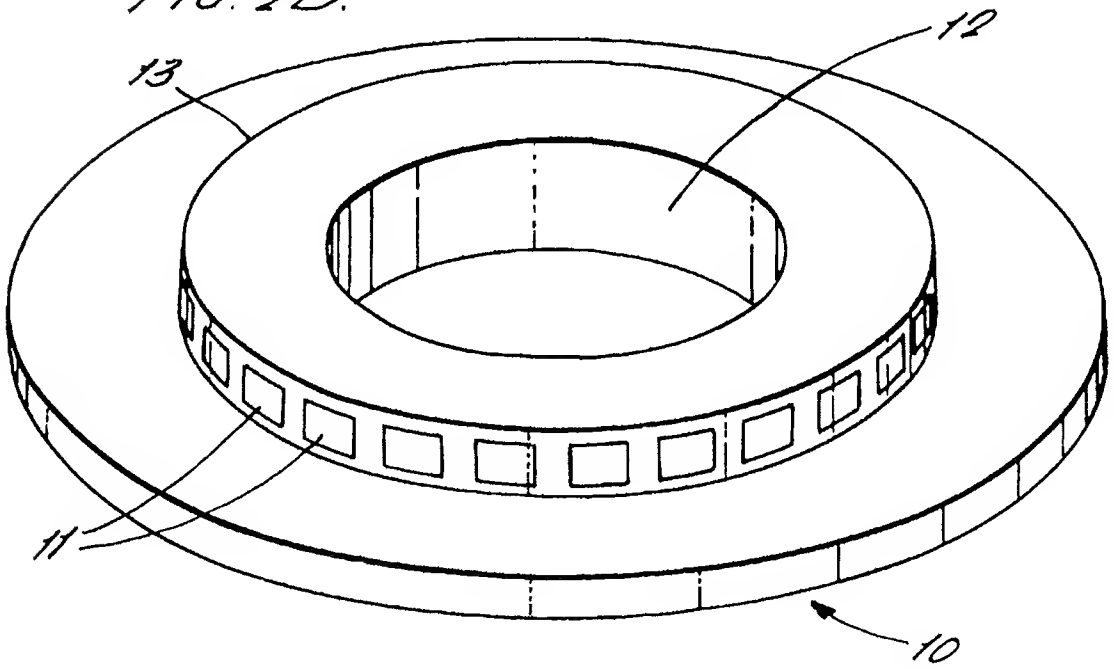


FIG. 3.

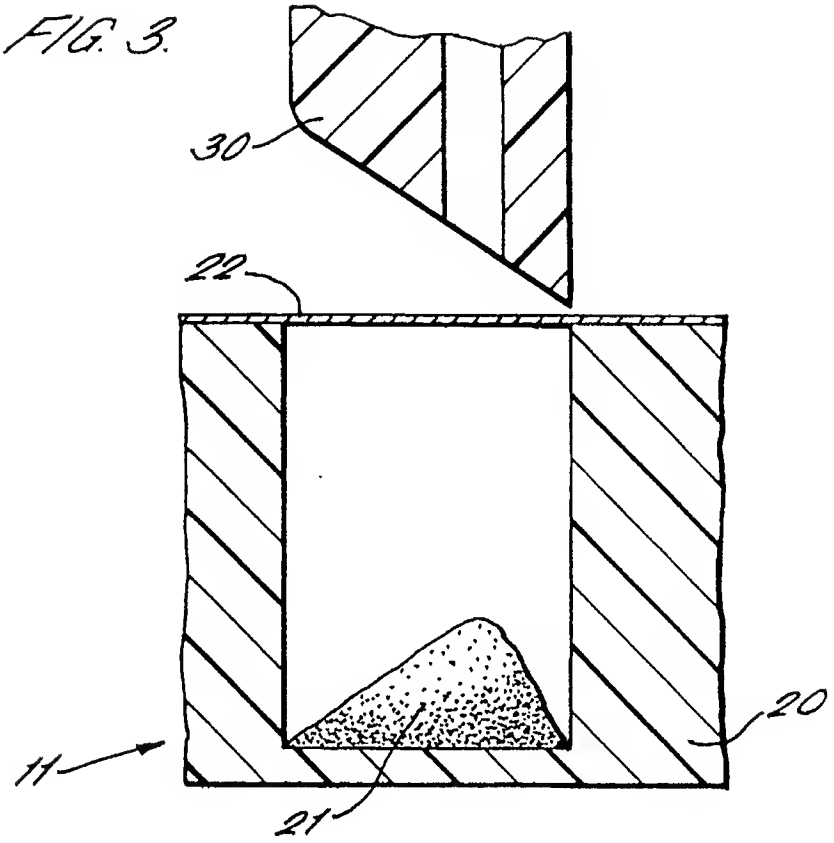


FIG. 4.

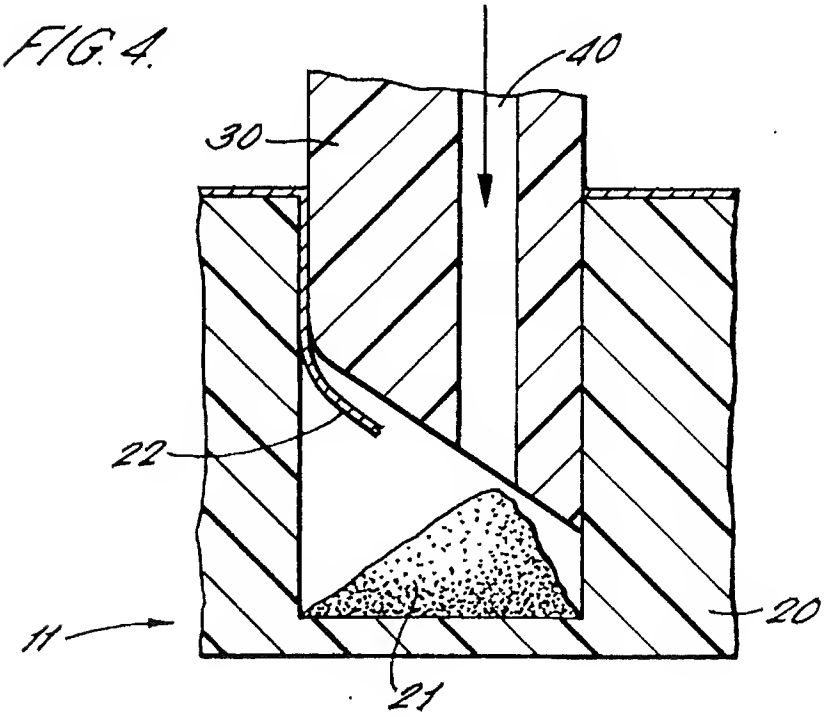


FIG. 5A.

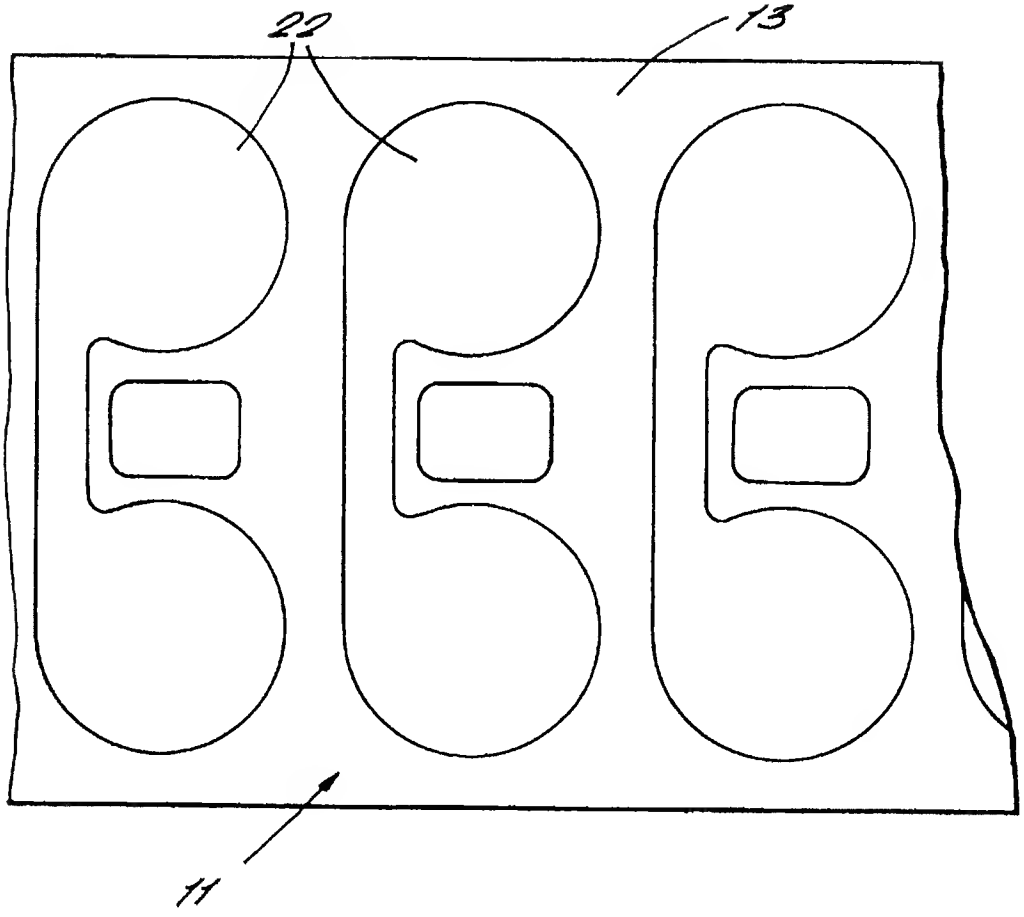


FIG. 5B.

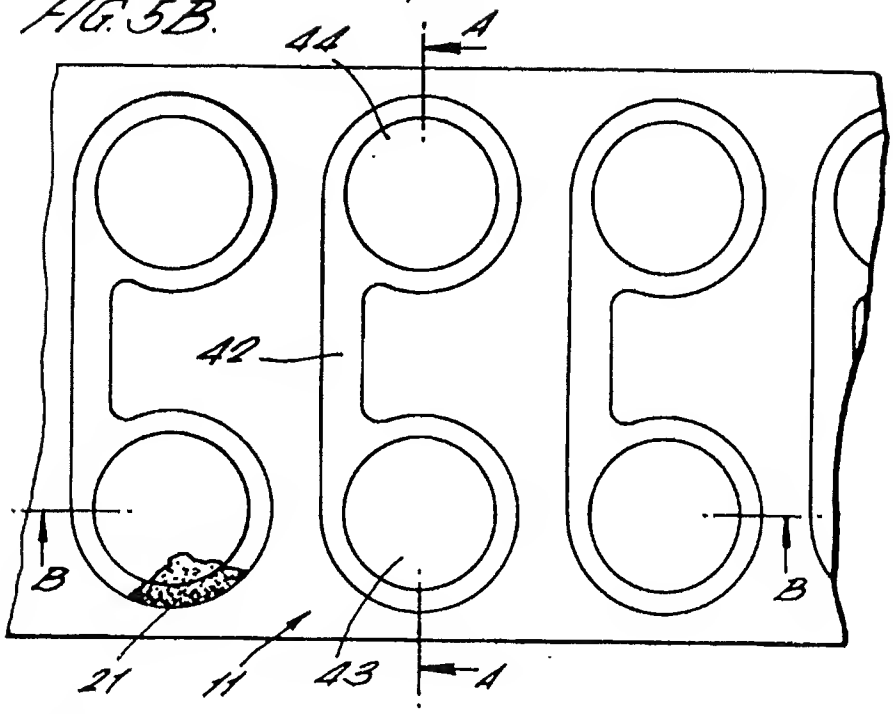


FIG. 6A.

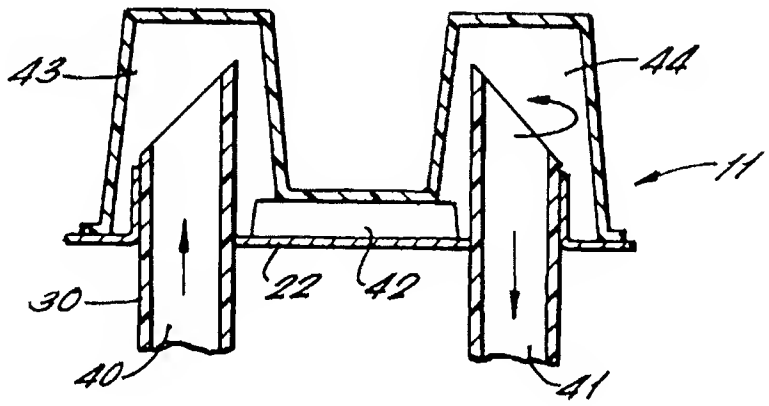


FIG. 6B.

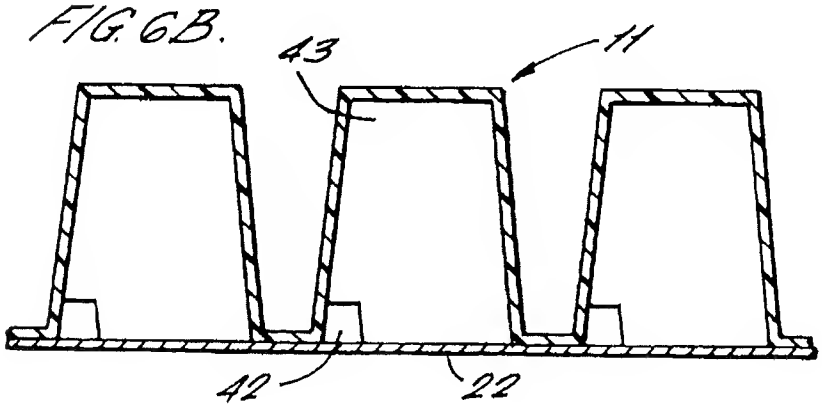
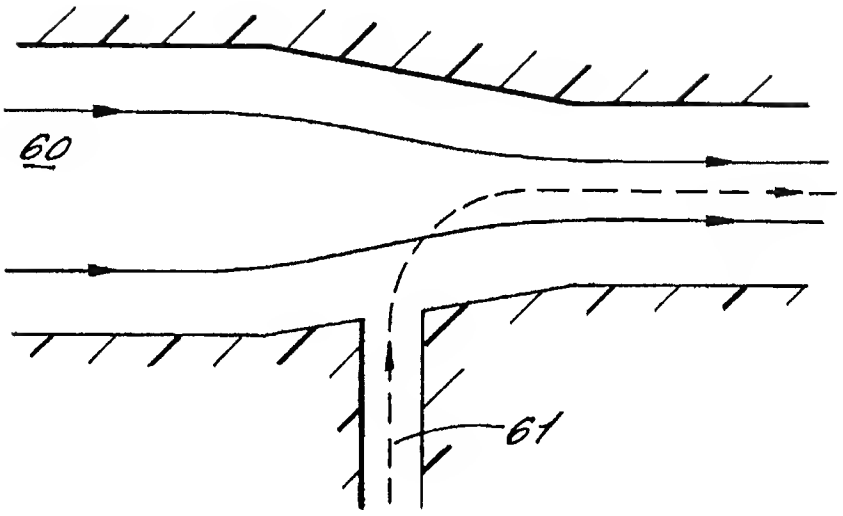


FIG. 6C.



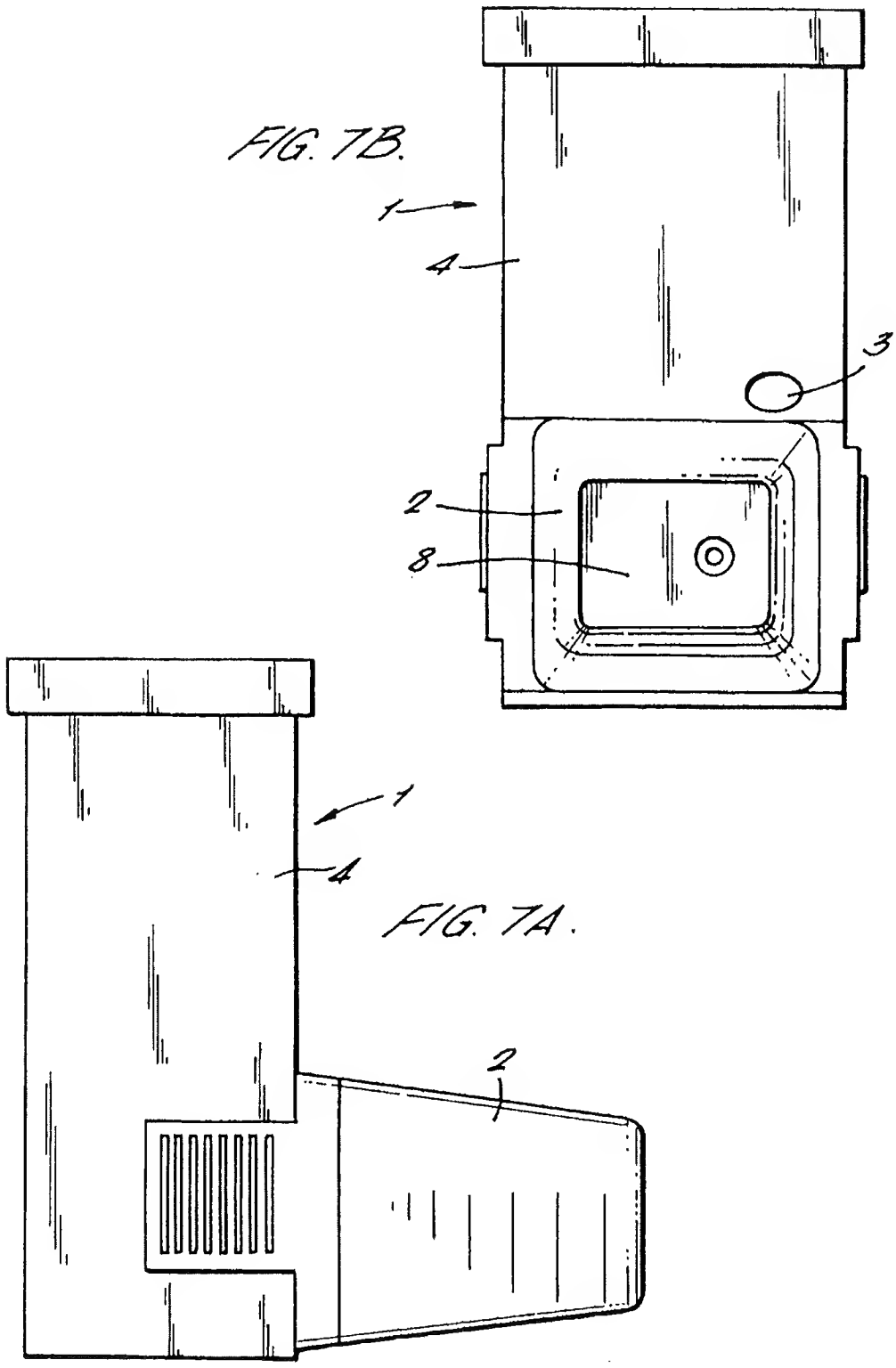


FIG. 7B.

FIG. 7A.

FIG. 8B.

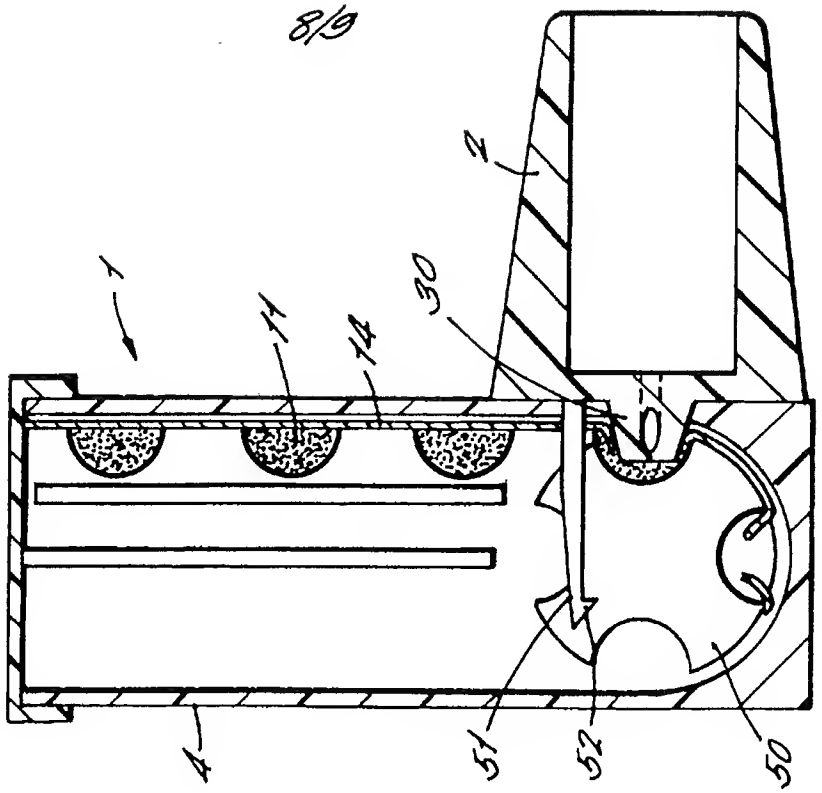


FIG. 8A.

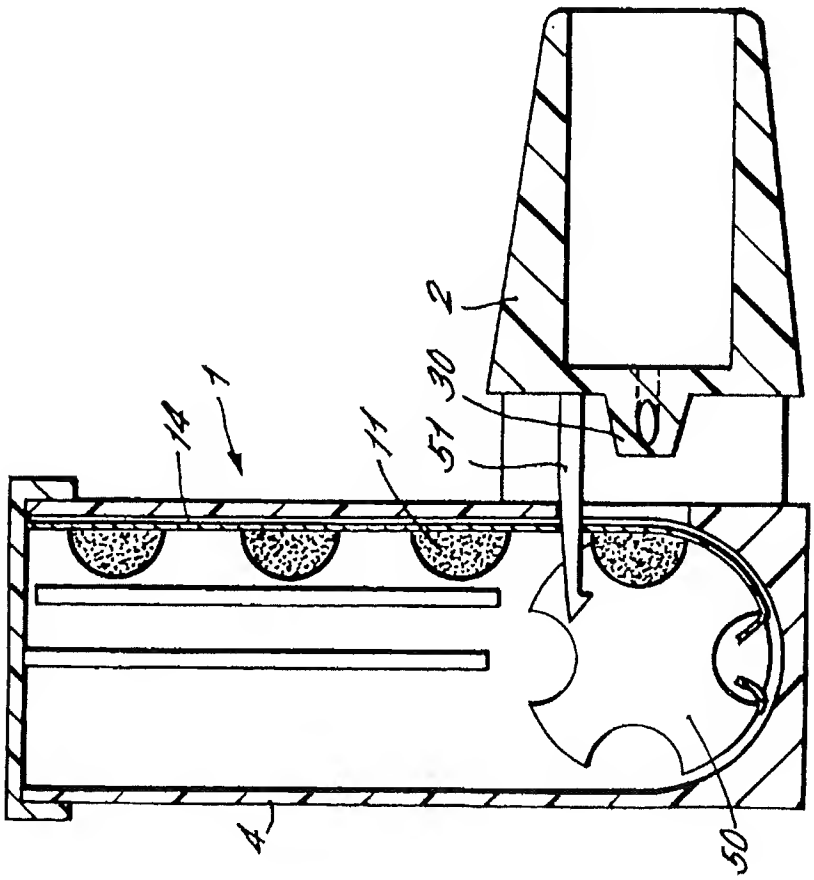


FIG. 9A.

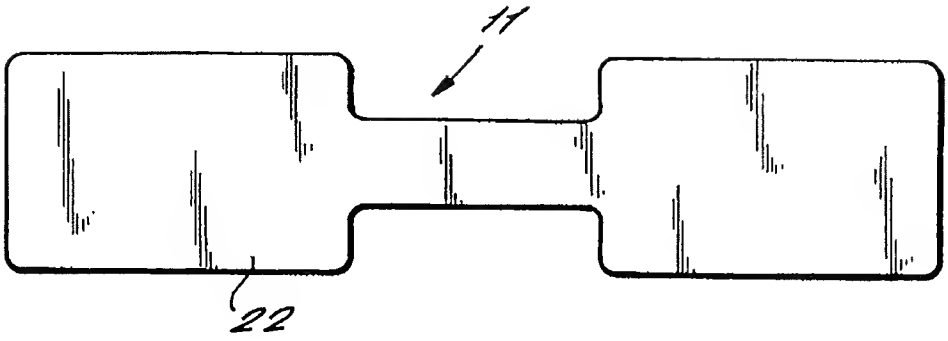


FIG. 9B.

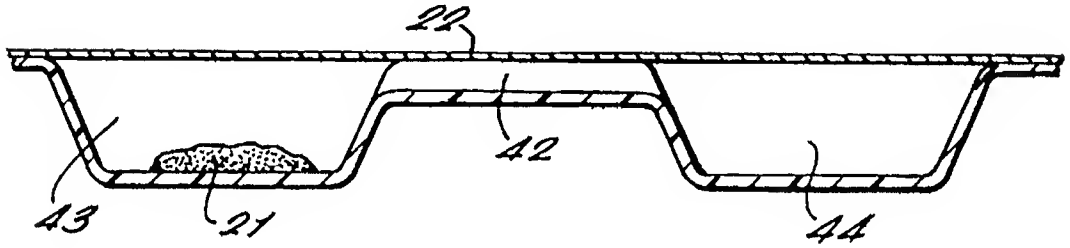
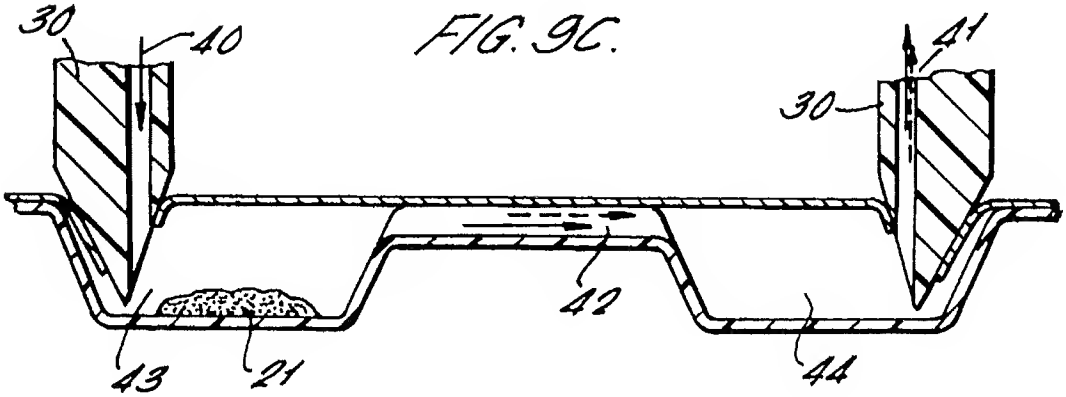


FIG. 9C.



DRUG DISPENSING SYSTEM

This invention relates to a drug dispensing system which is particularly useful for administering powdered drugs by inhalation.

It is well known to deliver medication for respiratory disorders, such as asthma, by inhalation. It is also known that to be most effective, such medication must be inhaled such that the medicament reaches deep into the lungs of the user. Medication may be delivered by liquid nebulisation, pressurised metered dose inhalers or by dry powder inhalers. This invention relates to improvements in dry powder inhalers.

In known dry powder inhalers, the powdered medicament, which is often combined with a powdered carrier, such as lactose, is stored within a delivery device until delivery of the medicament is required. It is known to store the medicament in a bulk holding reservoir within the delivery device. The drug is removed from the reservoir on an as required basis. The advantage of this type of system is that a large number of doses may be contained within one dispensing device, which may be disposable. Disadvantages with this type of device include the relative inaccuracy of the dose administered by the user. In particular, the accuracy of the dose administered may be adversely affected by the patient's actions. Additionally, the medicament contained within the bulk reservoir may be exposed to environmental conditions such as humidity

which may have adverse effects on performance.

It is also known to provide dry powder inhalers wherein the medicament is contained within discreet doses within a dosage unit such as a gelatine capsule. The capsule is then introduced into the delivery device on an as required basis and opened in some manner so as to expose the drug. In this type of device, the basic delivery device is re-usable. However, the loading of the discreet doses into the delivery device can be a complex operation which may be difficult for a user.

It is also known to provide, so-called multi-dose systems, wherein the medicament is contained as discrete doses in a form that consists of multiple doses. All of the doses may be contained within the delivery device or, alternatively, the delivery device may be re-fillable using, for example, a multi-dose cartridge. In use an individual dose is pierced by a needle or probe and the powdered medicament is transferred, under gravity or otherwise, into a primary airway from where it is inhaled by the user. A disadvantage with known multi-dose systems is that, due to the transfer of the medicament powder from the dosage unit to the primary airway, medicament may be lost from the device if the device is not handled with care during operation leading to inaccurate dosage to the user.

According to the present invention there is provided a dispensing apparatus for use with a powdered product comprising a housing, a mouthpiece defining an outlet, cartridge means disposed within

the housing comprising a plurality of dosage units each containing a dose of the product, the dosage units comprising one or more chambers sealed by a frangible membrane, the apparatus further comprising probe means and means to move the cartridge means relative to the probe means between actuations of the dispensing apparatus to prime the apparatus, the probe means being movable from a first, inoperative, position to a second, operative, position to pierce the frangible membrane and enter one of the dosage units, wherein the probe means comprises an air inlet connected to atmosphere and an air outlet connected to the mouthpiece such that when inhalation is applied to the mouthpiece by a user of the apparatus an airflow is created through the dosage unit from the air inlet to the air outlet to entrain the product therein.

In a first embodiment of the present invention the dosage units are in an annular arrangement within the cartridge means.

In a second embodiment of the present invention the dosage units are arranged linearly within the cartridge means.

Preferably the probe means comprises two prongs, one forming the air inlet and the other the air outlet.

In one version the dosage unit comprises a single chamber.

In an alternative version the dosage unit comprises two chambers, in the operative position the air inlet entering one chamber and the air outlet the other chamber. Preferably the dosage unit comprises a

restricted passage between the two chambers.

Preferably the cartridge means is replaceable.

It is an object of the present invention to provide a multi-dose re-fillable dry powder inhaler which has superior properties in terms of removal of the medicament and accuracy of dosing to the user.

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the following drawings, in which:

Figure 1A shows a schematic front elevation of a first embodiment of the present invention;

Figure 1B shows a schematic rear elevation of the device of Figure 1A;

Figure 1C shows a schematic side elevation of the device of Figure 1A;

Figure 2A shows a schematic perspective diagram of a first version of a multi-dose cartridge for use with the device of Figure 1A;

Figure 2B shows a schematic perspective diagram of a second version of a multi-dose cartridge for use with the device of Figure 1A;

Figure 3 shows a cross-sectional schematic side view of a dosage unit of the multi-dose cartridge of Figure 2A in an inoperative position;

Figure 4 shows a cross-sectional schematic side view of the dosage unit of Figure 3 in an operative position;

Figure 5A shows a radially inward looking view of a dosage unit of the multi-dose cartridge of Figure 2B;

Figure 5B shows a radially outward looking view of the dosage unit of Figure 5A;

Figure 6A shows a schematic view of the dosage unit of Figure 5B in operation sectioned at line A-A of Figure 5B;

Figure 6B shows a schematic view of the dosage unit of Figure 5B sectioned at line B-B of Figure 5B;

Figure 6C shows a schematic diagram of airflow through the dosage unit of Figure 3;

Figure 7A shows a schematic side elevation of a second embodiment of the present invention;

Figure 7B shows a schematic end elevation of the device of Figure 7A;

Figure 8A shows a cross-sectional schematic view of the device of Figure 7A in an inoperative position;

Figure 8B shows a cross-sectional schematic view of the device of Figure 7A in an operative position;

Figure 9A shows a schematic top plan view of a dosage unit of the device of Figure 7A;

Figure 9B shows a cross-sectional schematic view of the dosage unit of Figure 9A; and

Figure 9C shows a cross-sectional schematic view of the dosage unit of Figure 9A in operation.

Figures 1A, 1B and 1C show a first embodiment of the present invention. The device 1 comprises a housing 4 of a generally circular cross-section. The housing 4 consists of an upper shell 16 and lower shell 17 which define between them a chamber to receive a multi-dose cartridge 10 of generally circular shape. The lower shell 17 is provided with a central boss on which the multi-dose cartridge 10 is

adapted to sit for rotation within the chamber of the device 1. Normally a one-way ratchet mechanism is provided between the multi-dose cartridge 10 and the housing 4. A mouthpiece cover 62 is coupled to the upper shell 16. The cover 62 is rotatable relative to the upper shell 16 from a first position in which the cover 62 closes an aperture 63 in the upper shell 16 to a second position in which the aperture 62 is exposed. A mouthpiece 2 is provided within the housing 4 aligned with the aperture 63. The mouthpiece 2 is rotatable in a plane perpendicular to the plane of the housing 4 from a first position in which the mouthpiece 2 is fully contained within the housing 4 to a second position in which the mouthpiece extends substantially perpendicularly from the housing 4 such that a user of the device 1 may place the mouthpiece 2 in their mouth. The mouthpiece 2 defines an outlet 8. The mouthpiece cover 62 is coupled to the multi-dose cartridge 10. The mouthpiece 2 is coupled to a probe 30 comprising two hollow prongs as most clearly shown in Figure 6A. One prong forms an air inlet 40 and communicates with an exterior of the device 1 and atmosphere. The other prong forms an air outlet 41 and communicates with the mouthpiece 2 and outlet 8.

Preferably, a dosage counter 3 is provided within the device 1 in order to allow a user of the device 1 to read how many medicament dosages are left before re-filling is required. The dosage counter 3 may be a series of numbers printed on the cartridge 10 arranged circumferentially and visible through an aperture in the housing 4.

A first version of the multi-dose cartridge 10 is shown in Figure 2A. The cartridge 10 comprises a dosage wheel 13 circumferentially spaced around a central hole 12. The dosage wheel 13 comprises individual dosage units 11 arranged circumferentially around the dosage wheel 13. The dosage units 11 are shown in Figures 3 and 4 and comprise a single capsule 20 sealed at one end by a frangible membrane 22. The frangible membrane 22 is preferably a foil or other polymer laminate which is easily pierced. The capsules 20 may be formed in plastic by injection moulding.

Contained within the capsule 20 is a dose of medicament powder 21. The medicament powder 21 may be mixed with a carrier such as lactose. The medicament powder 21 is inserted into the capsule 20 at the point of manufacture and is sealed by the frangible membrane 22 before sale to a user of the device 1. In this way, the medicament 21 is isolated from environmental effects such as humidity and microbial infection, ensuring the medicament 21 reaches the user in optimum condition.

A second version of the multi-dose cartridge 10 is shown in Figure 2B. The cartridge 10 is similar to the first version except that the frangible membranes 22 of the individual dosage units 11 are positioned around the "rim" of the dosage wheel 13 so as to be directed radially outwards.

Figures 5A, 5B, 6A and 6B show the dosage units 11 for use with the second version of the multi-dose cartridge 10. Each dosage unit 11 comprises two chambers, an inlet chamber 43 and an outlet chamber

44, of generally truncated conical form sealed on one side by a frangible membrane 22.

The inlet chamber 43 and outlet chamber 44 are separated by a restricted passage 42. Medicament powder 21 is inserted during manufacture into the inlet chamber 43. Preferably, the dosage unit 11 is positioned in the housing 4 such that the inlet chamber 43 is lowermost and the outlet chamber 44 uppermost. In this way the effect of gravity, combined with the presence of the restricted passage 42, tends to retain the powdered medicament 21 in the inlet chamber 43 until use.

To operate the device 1 a user first rotates the mouthpiece cover 62 to open the aperture 63 and expose the mouthpiece 2. This action also primes the device 1 by rotating the multi-dose cartridge 10 one index point in order to position an unused individual dosage unit 11 in alignment with the probe 30. The user then rotates the mouthpiece 2 perpendicularly relative to the housing 4 causing the prongs of the probe 30 to contact and pierce the frangible membrane 22 of the dosage unit 11 as shown in Figures 4 and 6A. In the device 1 with the first version of the multi-dose cartridge 10 the probe 30 moves with a perpendicular component to the plane of the dosage wheel 13 to pierce the frangible membrane 22. Both the air inlet 40 and air outlet 41 of the probe 30 enter and remain within the single capsule 20. The user then places the mouthpiece 2 into their mouth and inhales causing an airflow to be created from the exterior of the device to the outlet 8 via the individual dosage unit 11. Air

enters the capsule 20 through the air inlet 40 of the probe 30 and exits via the air outlet 41. As the user inhales, the medicament 21 is entrained in the airflow through the individual dosage unit 11. The airflow through the capsule may be the primary airflow 60 created by the user's inhalation or a secondary airflow 61, such as a venturi effect, caused by the primary airflow, as shown in Figure 6C.

In the device 1 containing the second version of the multi-dose cartridge 10 the probe 30 moves with a radial component to pierce the frangible membrane 22. The air inlet 40 enters the inlet chamber 43 and the air outlet 41 the outlet chamber 44. The user then places the mouthpiece 2 in their mouth and inhales causing an airflow to be created from the exterior of the device 1 to the outlet 8 via the inlet and outlet chambers 43, 43 of the dosage unit 11. The presence of the restricted passage 42 in the second version of individual dosage unit 11 and the shaping of the inlet and outlet chambers 43 and 44 causes the airflow within the individual dosage unit 11 to develop vortices. These vortices aid the entrainment and separation of the medicament 21 from any powdered carrier. This has been found to be a useful effect to promote delivery of the medicament 21 to the lungs of the user.

Figure 7A and Figure 7B show a second embodiment of the present invention. The second embodiment as in the first embodiment comprises a housing 4 containing within a multi-dose cartridge 10 and one way ratchet mechanism 50. The housing 4 is generally cylindrical

or of rectangular cross-section. A mouthpiece 2 extends substantially perpendicularly from a lower end of the housing 4 and is movable along its own axis relative to the housing 4. Preferably, a dosage counter 3 is provided.

As shown in Figures 8A and 8B, the multi-dose cartridge 10 comprises a linear arrangement of individual dosage units 11 in a flexible sheet 14 which may be of plastic or other laminated material. The multi-dose cartridge 10 is arranged vertically within the housing 4 and extends downwardly into engagement with the index ratchet 50. A pawl 51 extends rearwardly from the mouthpiece 2 and co-operates with the ratchet 50 such that the ratchet is restricted to move only in a clockwise sense as viewed in Figure 8A. Additionally, the pawl 51 comprises a hook formation 52 at a distal end which engages the index ratchet 50 when the mouthpiece 2 is moved axially away from the housing 4 to rotate the index ratchet by one index point. The mouthpiece 2 comprises at a rearward end a probe 30 as previously described in the first embodiment.

As shown in Figures 9A, 9B and 9C, the individual dosage unit 11 for use with the second embodiment of the present invention comprises an inlet chamber 43 containing the powdered medicament to be dispensed and an outlet chamber 44 joined by a restricted passage 42. The inlet and outlet chambers 43 and 44 are sealed from the environment before use by a frangible membrane 22. Compared to the first embodiment of the device 1 the inlet and outlet chambers 43 and 44 are

relatively shallow.

To operate, the user of the device 1 pulls the mouthpiece 2 away from the housing 4 causing the pawl 51 to rotate the ratchet 50 by one index point to move an unused individual dosage unit 11 into alignment with the probe 30 and prime the device 1. The user then moves the mouthpiece 2 axially towards the housing 4 such that the probe 30 contacts and pierces the frangible membrane 22. One prong of the probe 30 enters the inlet chamber 43 and the other prong the outlet chamber 44. The user then applies suction to the mouthpiece 2 by inhaling causing an airflow to be created from the exterior of the device 1 to the mouthpiece 2 via the air inlet 40, inlet chamber 43, restricted passage 42, outlet chamber 44 and air outlet 41.

A particular advantage of the present invention is that the powered medicament 21 remains within the individual dosage unit 11 at all stages of operation of the device until inhaled by the user. There is no requirement to transfer the powdered medicament to another portion of the device before inhalation. This avoids the possibility of medicament 21 being lost by inadvertent handling of the device 1 by the user.

Claims:

1. A dispensing apparatus for use with a powdered product comprising a housing, a mouthpiece defining an outlet, cartridge means disposed within the housing comprising a plurality of dosage units each containing a dose of the product, the dosage units comprising one or more chambers sealed by a frangible membrane, the apparatus further comprising probe means and means to move the cartridge means relative to the probe means between actuations of the dispensing apparatus to prime the apparatus, the probe means being movable from a first, inoperative, position to a second, operative, position to pierce the frangible membrane and enter one of the dosage units, wherein the probe means comprises an air inlet connected to atmosphere and an air outlet connected to the mouthpiece such that when inhalation is applied to the mouthpiece by a user of the apparatus an airflow is created through the dosage unit from the air inlet to the air outlet to entrain the product therein.

2. Dispensing apparatus as claimed in claim 1 wherein the dosage units are in an annular arrangement within the cartridge means.

3. Dispensing apparatus as claimed in claim 1 wherein the dosage units are arranged linearly within the cartridge means.

4. Dispensing apparatus as claimed in any preceding

claim wherein the probe means comprises two prongs, one forming the air inlet and the other the air outlet.

5. Dispensing apparatus as claimed in any preceding claim wherein the dosage unit comprises a single chamber.

6. Dispensing apparatus as claimed in any of claims 1 to 4 wherein the dosage unit comprises two chambers, in the operative position the air inlet entering one chamber and the air outlet the other chamber.

7. Dispensing apparatus as claimed in claim 6 wherein the dosage unit comprises a restricted passage between the two chambers.

8. Dispensing apparatus as claimed in any preceding claim wherein the cartridge means is replaceable.

9. Dispensing apparatus substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

The Patent Office

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Application No:	GB 9818346.0	**Examiner:**	L.V.Thomas
Claims searched:	1-9	**Date of search:**	11 November 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): A5T (TBD)

Int Cl (Ed.6): A61M 15/00

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2048689 A	(SIGMA-TAU IND.) see p.1 ll.100-116 and p.2 ll.4-46	1
X	US 5533502	(PIPER) see col.2 l.21 - col.3 l.7, col.5 ll.4-23 and col.6 ll.53-67	1-5,8

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.